SOME ASPECTS OF THE REPRODUCTIVE BIOLOGY OF THE LION-TAIL MACAQUE—*MACACA SILENUS* (LINN.)—A ZOO STUDY[1]

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The reproductive biology of the lion-tail monkey at the Children's Park Zoo, Madras and at the Zoos at Bombay and at Kolhapur was studied. Two successive pregnancies of the same female were checked in our Madras study. The pregnant female did not show an enlarged belly ; palpation was not possible ; the female occasionally squeezed out milk from the nipples. A male baby was born (20th March 1976) which died after 4 months and 10 days, probably due to insufficiency of mother's milk. A second male baby was born of the same female on 6th March 1977, sired by the same male. This baby grew up well ; the mother died on 8th March. The coat colour of the babies was black but they had no mane at birth. When the second baby was examined 7 months later, a mane had grown. The probable period of pregnancy is 180-187 days. The sex skin cycle in this female was not followed. At the Bombay Zoo garden, two female lion-tails showed menstrual cycle with a mode at 39 days ; the menses (both overt and occult) lasted for 2-2.5 days. A summer amenorrhea was noticed. The sex skin tumescence started from day 6/7 of the cycle and reached a maximum on day 10. The subcaudal, perianal and paravulval (enclosing the callosities) tumescences were prominent. Detumescence was noticed from days 22-27 of the cycle. Probably ovulation takes place around 21/22 days of the cycle when the sex skin starts wrinkling. Vaginal cytology showed the presence of cornified or superficial cells at this time. Copulations generally took place at this time. On 24th July 1979, a male baby was born and when Ramaswami examined this lively baby on 30th March 1981, he was 1 year, 8 months and 10 days old. At the Kolhapur Zoo garden, a female lion-tail gave birth to a male baby years ago (which is continuing to live) and there were no further conceptions and one of the reasons for this may be that the female lived in constant dread of the vicious male in the same cage.

Introduction

The lion-tail macaque is restricted to the southern part of the Western ghats of India from Jog Falls to Agasthya Ranges (Kurup 1977). From south of Bramhagiri ranges in Coorg, the Nilgiri langur *Presbytis johnii* also with a similar coat colour, is a congener with the lion-tail monkey. The latter is readily distinguished by its grey facial mane and short tufted tail. Both were considered to be endangered species but while the Nilgiri langur shows an upward trend, the lion-tail is still very much endangered. Two recent estimates of the lion-tail put the total population as 405 by Green and Minkowasky (1977) and 800 by Kurup (1977).

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Observations and Discussion

At the Children's Park Zoo, Guindy, Madras (India), they have a pair of lion-tail monkeys ; the male was procured from the wild on 28th April 1970. An adult female, which was a pet with a family, was donated to the Zoo on 25th March 1975 and she was housed with the male. She was probably cycling regularly. The Forest Officer in charge of the Park Zoo told us of the characteristic sex skin in the

posterior region of the female waxing and waning.

Kurup and Ramaswami examined the above female at the Park Zoo on 23rd January 1976. The sexual swelling had completely detumesced but the vulval area was red in colour. The vaginal temperature was 101.6°F. A vaginal smear was taken with great difficulty but it did not disclose any cornified cells. No external manifestation of pregnancy was apparent and rectal palpation was not possible as she was too sensitive to handling. However, a male baby was born on 20th March 1976. When we examined the female very clearly on 23rd January 1976, she was pregnant, 56 days prior to parturition. Assuming that the period of gestation was 187+? days in this, as it was in the second pregnancy which we also studied, she must have conceived by about the middle of September 1975. From the time of admission (25th March 1975) to the middle of September 1975, we are not sure of the cycles she may have passed through keeping in mind the summer amenorrhea in these macaques and that each cycle lasts around 39 days in the lion-tail monkey.

From the date of admission to the Park Zoo to the end of September 1975, no record of the reproductive life of this female was maintained. When the female delivered a baby, the adult male was moved into another cage.

The baby had a blackish coat with no mane. It was 4 months and 10 days when it died (1st August 1976). The Park Zoo authorities felt that the death was due to insufficiency of mother's milk but hand-rearing was not resorted to as it was found difficult to separate the suckling baby from the mother. Birth of lion-tail macaques from an Indian Zoo (Delhi) has been reported by Sankhala and Desai (1969).

The Park Zoo authorities let the male and female lion-tails together again during the second week of September, 1976. Monkeys which go generally into summer amenorrhea, return to cycle by about the middle of August. The male was noticed to mount the female a number of times and he was then separated. Kurup and Ramaswami examined this female on 15th November 1976. The sex skin including the subcaudal one had completely detumesced and the vulval area was red in colour as on the previous examination. If the female had been impregnated during her stay with the male, she must be pregnant again, 3 months and 15 days after the death of the first baby. As before, palpation of the abdomen did not help. It is difficult to say when the female lion-tail started cycling but according to information from the Park Zoo authorities, she became receptive only after the death of the first baby (1st August, 1976). No record of the tumescence of the sex skin, after the death of the baby and after she renewed her cycles, had been maintained.

On 4th February 1977, Kurup and Ramaswami again examined the same lion-tail female at the Park Zoo, Guindy, Madras. The detumesced condition of the sex skin continued but the ischial callosities were hard. The whole vulval region was red in colour and sensitive to handling. The vaginal temperature was 101.0°F., and the smear did not disclose any superficial cells. Abdominal palpation was not helpful and she did not permit a rectal one. The breasts were enlarged and she occasionally squeezed out milk from the pink teats. This is not unusual in pregnant monkeys. Speert (1948) proved that in the pregnant rhesus monkey, by the end of the 4th month, secretory activity in the mammary glands was well established ; this continued to increase up to term (165 days). In the human female, according to Jeffcoate (1967), ' milk is never produced

until the placenta is delivered or ceases to function '. Monkeys seem to differ from the human species in this.

A male baby (christened Reuben) was born of this female on the afternoon of 6th March 1977 which both Kurup and Ramaswami examined on 29th March 1977. His coat was completely black with no mane confirming our observation on the previous occasion. His face, hands and feet were pinkish. Unfortunately the mother died on 8th March 1977. The baby was being bottle-fed and he sucked his right thumb incessantly. This is also noticed in human babies which are weaned prematurely. We examined Reuben almost 7 months later, on 5th October. He had grown up and had developed a grey mane. He ran about freely and had become a loved pet. He had started eating solid food including tender shoots and had abandoned his thumb-sucking habit. According to Green and Minkowaski (op. cit.), the lion-tail female may not give birth to more than 2-3 babies in her life-time since the adults are not long-lived.

According to Sugiyama (1968), the new-born lion-tail baby has brown hair and pale pink skin. One month later, the skin colour changes to a pale brown or grey.

Assuming that impregnation took place in the first week of September 1976 in the lion-tail examined by us (after which the female was separated from her mate) the gestation period works out to 180-187 days. This is not very much out of the mark as Macdonald (1971) reported a maximum of 190 days in *M. arctoides* and in its nearest relative *M. nemestrina*, it ranged from 162-179 days (Kuehn, Jensen and Morrill 1965 ; Tokuda, Simons and Jensen 1968). Regarding birth of babies, Webb-Peploe (1947) stated that in southern India, lion-tail babies were born in September ; Prater (1971) also stated that young lion-tails were seen regularly in September. Sugiyama (op. cit.) noted that lion-tail young were born in January and that there was no restricted mating season. Sankhala and Desai (op. cit.) reported seven lion-tail births from January to October, indicative of breeding throughout the year.

At the Ranibaug Zoo Garden, Bombay, there were three lion-tail monkeys added in April 1973. Gadgil and Ramaswami examined them regularly starting from January 1976. Another consignment of lion-tails, 2 males and 3 females, was added to the Zoo on 23rd November 1976 after rescuing them from a local dealer and housing them for a few months in the Karnala National Park, Maharashtra. Of the first lot of three females, two were regularly cycling even in the absence of a male and the third one had not reached menarche. Female No. 1 of this lot was in menses on 9th January 1976. Usually there is both overt/occult menses of 2-2.5 days in these animals and the vaginal swabs disclosed the latter type. The next menstruation in this female was on 16th February 1976 ; the cycle was of 38 days. Again she menstruated on 17th March ; this cycle was of 30 days. The third cycle which we studied on 4th April 1976 was of 20 days duration. This animal was again studied during the end of 1976 and the following year. She menstruated on 9th December 1976 ; 16th January 1977 ; 23rd February and 3rd April ; these consecutive cycles were of 39 days duration. The second female also showed similar consecutive cycles of 39-40 days duration. Asakura (1960) reported a cycle length of 39.6 days in the lion-tail (under its older specific name *albibarbata*) and menses of 2.5 days in the zoo lion-tails studied by him in Japan. In our animals, we studied the cyclical nature of the sex skin in relation to the menstrual cycle. The growth of the sex skin started from day 6/7 and on day 10 of the menstrual

cycle, the sex skin was highly tumescent and it continued in this condition for another 11-12 days. The subcaudal sex skin was reniform, either side of it projecting above the tail ; these side projections eclipsed the perianal swellings and by pushing the subcaudal above, the perianals could be made out. The perivulval were the largest swellings and each one enclosed the ischial callosity of its side and at the height of tumescence, the vulval region, pink in colour, was not visible externally. We have never noticed the right and left perivulval sex skin uniting to form a single one as described by Hill (1937). The ischial callosities were soft at this time and were completely embraced by the sex skin. From days 22-27 of the cycle, detumescence was noticed and this was completed well before the beginning of the next cycle. The perianal and perivulval swellings completely detumesced quickly, the skin showing more and more shrinkage and the ischial callosities becoming hard again ; the subcaudal swelling was no more reniform but persisted for a few more days as a prominent swelling at the base of the tail into the next cycle. From the day detumescence started, it took 17-18 days for the next catamenia to occur. According to Asakura (op. cit.), the sexual skin cycle was of 14.5 days duration. Fooden (1975) draws a figure (Fig. 11, p. 29) of the posterior of the lion-tail, based on the work of Pocock (1925) and of Hill (op. cit.), and compared it with that in the pigtail *M. n. nemestrina*. The figure of the lion-tail was a poor representation of what we have seen on more than one occasion in the same lion-tail in the zoo and also in other lion-tail females. His figure was of a lion-tail from the Lincoln Park Zoo showing the beginning of tumescence and the maximum development of the sex skin had yet to take place.

If, as in the pigtail, baboon (Hendrickx and Kraemer 1970) and the chimpanzee (Keeling and Roberts 1972), ovulation took place at the peak of tumescence and prior to the onset of detumescence in the lion-tail monkeys, it would be around days 21-22 of the cycle when the female was at the height of the heat period ; it was during this period that frequent copulations took place. No discharge of mucus was noticed during this period. The luteal period was probably 18 days. According to Sugiyama (op. cit.), the sexual skin surrounding the anus and vulva of an oestrous female may or may not be swollen. We have always seen swollen sex skin in cycling female lion-tails at the height of the follicular phase.

Two sets of workers (Kuehn, Jensen and Morrill op. cit. ; Tokuda, Simons and Jensen op. cit.) reported that the cycle length in the pigtail was 32-40 days. According to the latter authors, the tumescent and quiescent periods of the sex skin were 21 and 17 days respectively. In the same species, Bullock, Paris, Resko and Goy (1968) noted that ovulation took place on the first day of detumescence ; this observation was confirmed by a study of plasma oestradiol and progesterone assay by Eaton (1973). White, Blaine and Blakley (1973) described that vaginal cytology and body temperature did not help in pinpointing the day of ovulation in the pigtail. Perineal tumescence helped in separating the luteal phase from the follicular ; maximal tumescence was seen within 12 hrs of ovulation. In a cycle length of 28 or 29 days, the maximum swelling lasted 1-3 days in three different cycles. In a further study of the pigtail monkey, Blakley, Blaine and Morton (1977) pointed out that ovulation and the first signs of detumescence occurred within a 24 hrs period.

Gillman (1935) reported that in the baboon there was a sudden decrease in all measurements of the sex skin at midcycle and then reached a maximum within the next two or three days ;

he associated the decrease with ovulation in this animal.

At the Bombay Zoo Garden, just before the sex skin started detumescing in a female lion-tail (22-23 December 1976), a male, which had been received from the Karnala National Park, was introduced into the cage ; the female was a regularly cycling one which we had studied. He mounted her several times and each time there were five pelvic thrusts. The mode of copulation resembled that in other macaques (Tokuda 1961-62). The female did not conceive. However, at a later date, a male baby was born on 24th July 1979. This baby has grown up nicely and goes about moving out of the cage, receiving eatables etc., and then gets back into the cage. When Ramaswami examined the baby on 30th March 1981 (with the assistance of veterinarian Dr. M. S. Karawale) he was looking healthy and was aged 1 year, 8 months and 10 days ; weaning had not yet taken place. The Zoo has seven lion-tails, 5 females and 2 males, one of the latter being the juvenile referred to above.

Our examination of the vaginal cytology of the female lion-tails disclosed an interesting evidence of the possible time of ovulation. At the height of tumescence and before the start of detumescence (22-23 days of the cycle), large number of cornified cells (superficial cells) were noticed in the smear, stained pinkish by the Papinacoloau technique ; no other cells were present. This probably was also the time of ovulation. Such scales also appeared in lesser numbers in the smears in the days following the start of detumescence (noticed as shrinkage of the sexual skin) and they do not show any rolled edges as in the luteal phase smear of the human female (Jeffcoate op. cit.). As the female approached the day of menses, the smear swab showed a pink colour as in the human female and thereafter both overt and occult menses took place. Leucocytes and cyanophilic intermediate cells preponderated in the menstrual smear while in the days following menses, there were scales, a few intermediate cells and a few leucocytes. This appeared to be the general pattern of cell types during menstruation studied over a large number of cycles in two females. The occurrence of a large number of only superficial cells coinciding with the height of tumescence (21-22 days of the cycle) would restrict the time of ovulation to those days and the secretory phase started from day 22-23 when the sex skin also started shrinking. The vaginal temperature was of no use in deciding the day of ovulation.

At the Kolhapur Zoo Garden (Maharashtra), there are two pairs of lion-tails ; no records of these have been maintained. One female gave birth to a male baby. No further conceptions took place. This may be due to the very aggressive nature of both the males which kept the females in a state of tension.

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Since sending the Ms. to the press and receiving the galley proof, there has been a Conference on the lion-tailed monkey at Baltimore, U.S.A. Comprehensive accounts of studies made on the monkey at various zoos were reported at the Conference by Lasley, Czekala, Lindburg, Shideler, Fitch (San Diego Zoo) and Kempske (Baltimore zoo) and an account of the reproductive behaviour of the animal in wild has been given by Kumar and Kurup. Both Drs. Kurup and Gadgil attended the Conference and from the Mss. brought by the former, the following highlights are culled :

1. The male is a multiple mount ejaculator (Kumar & Kurup ; Lindburg).

2. The menstrual cycle is of 30 days duration (Lasley, Czekala & Lindburg) or 30-36 days (Kempske) and ovulation (using the oestrogen peak as a parameter) takes place around 14th day of the cycle and the luteal phase is of 16 days. The reported difference in cycle length is due to differences in the follicular phase of duration. It has also been shown in their Table that estrone of the oestrogens is the major urinary metabolite (Lasley, Czekala & Lindburg) like many other monkeys.

3. The sex-skin behaviour is highly variable and therefore not dependable for pinpointing the day of ovulation in the lion-tail macaque.

4. The period of pregnancy may range from 154-186 days (mean 172 days) (Kempske).

5. The animals are not short-lived as opined by Green & Minkowski from their study in wild and have been living for more than 33 years in the Baltimore zoo.

6. In wild population, the sex-skin swelling lasts for 34.33 days ; copulation thrusts are 3-16. Conception takes place during June-July (S.W. monsoon) and December (N.E. monsoon) (Kumar & Kurup).

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